ANKLE BRACING'S EFFECT ON LOWER EXTREMITY ELECTROMYOGRAPHIC ACTIVITY AND VERTICAL GROUND REACTION FORCE DURING JUMP LANDINGS - PILOT STUDY RESULTS

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Ankle braces are often worn to prevent ankle injuries. Evidence supports their ability to prevent ankle injuries; however, the effects that ankle braces have on proximal biomechanics and injuries is unclear. This pilot study explored the effects of ankle braces on lower extremity electromyographic (EMG) activity and vertical ground reaction force (vGRF) during a jump landing. Ten healthy individuals completed 3 maximum vertical jumps under 3 bilateral conditions (no braces, softshell (AE) braces, and semi-rigid (T1) braces). Mean EMG activity and peak vGRF was recorded from the dominant leg at landing. No significant differences in lower extremity EMG activity or peak vGRF was present when wearing ankle braces. Trends exist in the data that warrant further investigation in a larger sample.

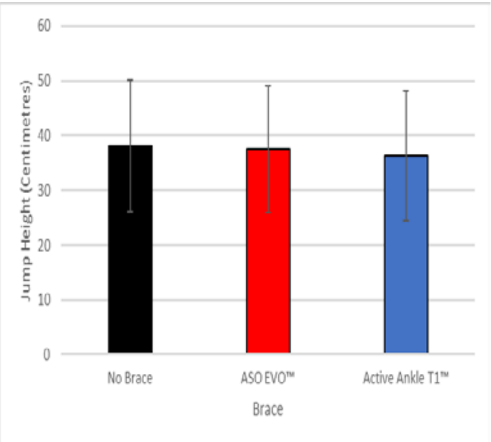
KEYWORDS: External ankle support, jump landings, ankle injuries, kinetics, athletic performance, electromyography

INTRODUCTION: In volleyball, up to 86% of ankle injuries occur when landing from a jump (Bahr, Karlsen, Liam, & Øvrebø, 1994). Due to this inherent risk, ankle braces are frequently employed by athletes, coaches, and healthcare providers to prevent ankle injuries (Stasinopoulos, 2004). Nevertheless, in high school basketball players who wore ankle braces, an 85% increase in non-ankle lower extremity injuries was noted by McGuine, Brooks, and Hetzel (2011), suggesting that further research be done on the biomechanical effects of ankle bracing. Multiple mechanisms have been proposed to explain ankle bracing's ability to decrease ankle injuries, including restricting ankle range of motion (ROM; Verhagen & Bay, 2010) and improving proprioception at the ankle (Olmsted, Vela, Denegar, & Hertel, 2004). How this restriction in normal ankle ROM affects jump landing biomechanics, specifically muscular activation of the lower extremity and ground reaction forces (GRFs), however, remains unclear. Restricting normal plantarflexion ROM during the squat has been noted to decrease quadriceps muscle activity and increase soleus muscle activity (Macrum, Bell, Boling, Lewek, & Padua, 2012). As the quadriceps muscle group functions to extend the knee and flex the hip (Tortora & Nielson, 2010), this may indicate a reduction in knee flexion and hip extension when plantarflexion ROM is restricted during squatting. If similar changes were to occur when jumping, this could have implications for lower extremity injury risk, performance, and compensation in the segments above. Adequate knee flexion and muscular activation of the lower extremity has been associated with a reduction in GRFs (Devita & Skelly, 1992) and the inability to attenuate GRFs has been hypothesized to contribute to lower extremity injury (Dufek & Bates, 1990). In the only study to examine lower extremity muscle activity during a jump landing when wearing softshell ankle braces, Hopper, McNair, and Elliot (1999) observed a significant decrease in gastrocnemius and peroneus longus (PL) electromyographic (EMG) activity, but no changes in GRFs or ankle kinematics. As such, it is possible that ankle braces may alter EMG activity at the ankle, but not affect GRFs when wearing softshell ankle braces. When wearing semi-rigid ankle braces, however, vGRF was noted to increase during a standardized drop landing (Hodgson, Tis, Cobb, & Higbie, 2005). As such, differences appear to exist between ankle brace types with respect to their effects on GRFs. Additionally, a limited number of studies have examined the effects of ankle braces on GRFs during a drop landing, and no studies have examined EMG activity of proximal leg musculature when wearing ankle braces during a jump landing. Therefore, the purpose of this pilot study was to examine the effect of softshell and semi-rigid ankle braces on EMG activity in the lower extremity and vertical ground reaction force (vGRF) during a vertical jump landing.

METHODS: Once ethical approval was granted by the academic institution, 10 healthy, active individuals (5 male, 5 female, mean age: 23.20 +/- 1.14 years, mean height 175.80 +/- 7.21 cm, mean weight 74.40 +/- 7.85 kg) were recruited into the study. Participants completed a 5 minute warmup on a cycle ergometer before having the electrodes of a Delsys Trigno™ wireless EMG system applied to their dominant leg. Electrodes were applied to the PL, lateral gastrocnemius (LG), biceps femoris (BF), gluteus medius (GM), and rectus femoris (RF) muscles. Electrode location was based on the Surface Electromyography for the Non-Invasive Assessment of Muscle (SENIAM; 2016) guidelines. Following the application of each electrode, participants performed a maximum voluntary contraction (MVC) for each muscle, during which EMG activity was recorded. Participants were then introduced to the Vertical Jump Test, which was based on the Canadian Society for Exercise Physiology (2013) guidelines. To begin each jump, participants stood parallel to a Vertec™ device, feet shoulder width apart, with the dominant foot over a force platform. Participants then lowered into a 45 degree semi-squated position while their arms moved backwards as a counterweight. In this position, participants paused for two seconds, before jumping and touching the Vertec™ device as high as possible. Upon landing, participants were to have their weight evenly distributed over both feet, with their dominant foot in contact with the force platform. Participants were allowed practice trials to familiarize themselves with the procedures, after which 3 maximum effort trials were completed where vertical jump height (cm) was recorded, in addition to EMG (mV) and GRF (N) data at landing. After the completion of 3 recorded trials with no ankle braces (NB), a 5 minute transition period ensued to allow for each participant to physically recover and apply the ASO EVO™ (AE) ankle braces. Once the AE braces were applied, participants completed 3 more recorded trials, after which another transition period took place. During the second transition period, participants applied the Active Ankle T1™ (T1) semi-rigid ankle braces and once again performed 3 recorded trials.

Results: The Friedman's test revealed no significant differences (p > .05) between conditions with respect to vertical jump height, EMG measures, or vGRF. Means and standard deviations are displayed in Figure 1a, 1b, and 2.

(a)



(b)

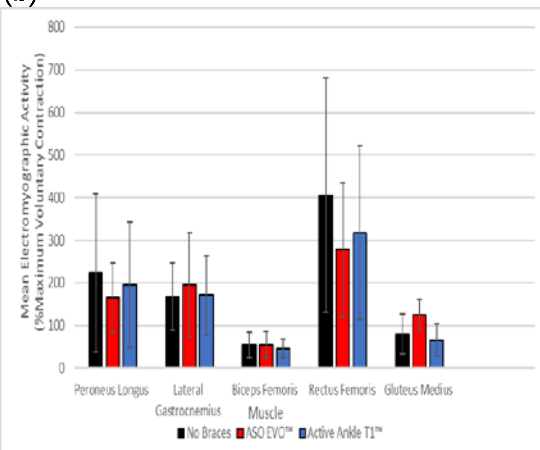


Figure 1: Changes in mean values across conditions. (a) Vertical jump height with and without ankle braces; (b) mean electromyographic activity during landing with and without ankle braces.

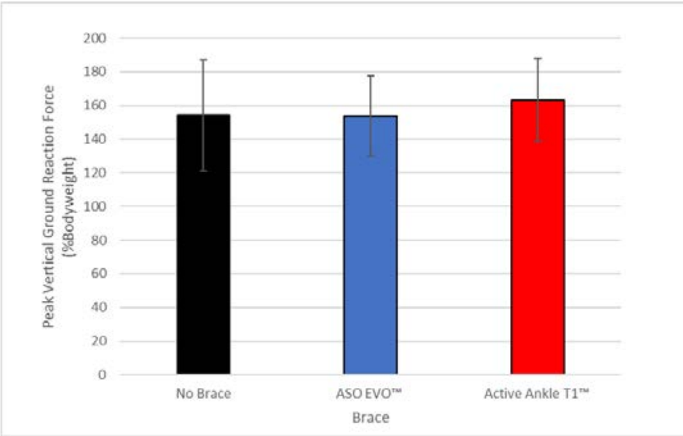


Figure 2: Mean peak vertical ground reaction force during landing with and without ankle braces.

DISCUSSION: The primary purpose of this pilot study was to determine if EMG activity of the lower extremity and vGRF were affected by softshell and semi-rigid ankle braces during a jump landing. No significant differences were observed between conditions for measures of EMG activity, vGRF, or vertical jump height. These results contradict previously observed increases in vGRF (Hodgson et al., 2005) and decreased EMG activity (Hopper et al., 1999) during landing tasks, as well as decreased vertical jump height (Smith, Claiborne, & Liberi, 2016) when wearing ankle braces. From a methodological perspective, the lack of significant differences seen in this study may be the result of the task used and low sample size (n=10). While a countermovement vertical jump was used in this study to create a bilateral jump landing, Hodgson et al. (2005) utilized a hanging drop landing, removing the take-off portion of a jump. As such, pre-activation of the lower extremity muscles may have been diminished without a take-off component, reducing the ability to attenuate potential increases in vGRF caused by semi-rigid ankle braces. In comparison, by utilizing a bilateral take-off and landing task in this study, lower extremity muscular activity may have been increased prior to landing, potentially mitigating vGRF irrespective of brace condition. The use of a bilateral take-off and landing may also explain why no differences in EMG activity between conditions was observed in this study relative to previous literature. Hopper et al. (1999) employed a unilateral take-off with a single leg landing task. Unilateral jump landings have been noted to produce greater EMG activity of the lower extremity pre-landing than bilateral landings (Tillman, Criss, Brunt, & Hass, 2004). Additionally, unilateral jump landings have been shown to produce greater vGRF than bilateral landings (Tillman et al., 2004). As previously hypothesized by Cordova, Armstrong, Rankin, James, and Yeasting (1998), the decrease in lower extremity EMG activity observed by Hopper et al. (1999) may be indicative of the ankle brace attenuating external forces, reducing the loading on the musculoskeletal system. As bilateral jump landings produce less force and lower extremity EMG activity than unilateral landings, the use of a bilateral take-off and landing in this study may not have produced enough stress on the musculoskeletal system to observe changes in EMG activity or vGRF.

While no significant differences were revealed between conditions, some intriguing trends were present. Vertical jump height slightly decreased when wearing ankle braces, which is consistent with recent results from Smith, Claiborne, and Liberi (2016). In regards to vGRF at landing, previous literature has established that GRF should increase exponentially as jump height increases (Yeow, Lee, & Goh, 2009). As such, lower jump heights should result in smaller GRF values; however, this was not the case. Vertical jump height decreased by an average of 1.78 cm when wearing T1 ankle braces, despite an increase in peak vGRF of 9 N from the NB condition. Therefore, it would appear that T1 ankle braces may slightly increase vGRF during a jump landing. Along with an increase in vGRF in the T1 ankle brace condition, RF EMG activity decreased when wearing the AE and T1 ankle braces, respectively. As greater lower extremity muscular activation (Devita & Skelly, 1992) and knee flexion angle

(Dufek & Bates, 1990) has been associated with attenuation of GRFs, it is logical to suggest that this reduction in RF activity during landing when wearing the T1 ankle braces could contribute to the increase in peak vGRF. The exact implications of this potential reduction in RF EMG activity, however, are unclear without further investigation.

CONCLUSION: Although no significant differences were observed, there were trends in the data that warrant further investigation using a larger sample. As such, the results of this pilot study provide the bases for further investigation into the effects of softshell and semi-rigid ankle braces on lower extremity EMG activity and vGRF during a vertical jump landing.

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